

**National Exposure Research Laboratory
Research Abstract**

Government Performance Results Act Goal: Clean Air

Significant Research Findings:

Particulate Matter Longitudinal Panel Studies**Scientific Problem
and Policy Issues**

The NERL Particulate Matter Longitudinal Panel Studies were used to characterize temporal variation of personal exposure to PM and related co-pollutants, including that of PM measured at ambient sites. These studies were fundamental in understanding the associations between personal exposure to PM, PM measured at ambient sites, and health effects, especially for susceptible sub-populations. Projects were designed to evaluate different sub-populations, regions of the country, seasons, and housing conditions. Susceptible sub-populations included chronic obstructive-pulmonary disease (COPD) patients, individuals with cardiovascular disease, the elderly, and asthmatics. These studies represented a cooperative effort between the NERL and other scientific organizations. Collected data is being used to develop databases representing actual human exposures. These data fill a critical scientific need for the Agency in identifying potentially important exposure variables, as well as providing inputs for modeling and risk assessment.

Research Approach

The NERL Particulate Matter Longitudinal Panel Studies represent a series of human exposure studies implemented by various internal US EPA organizations (The NERL and the National Health and Environmental Effects Research Laboratory) as well as Agency-sponsored external research organizations (Harvard University, New York University, University of Washington, Research Triangle Institute). Beginning in 1997, studies were conducted in Baltimore, Maryland; Fresno, California; Seattle, Washington; Atlanta, Georgia; Boston, Massachusetts; New York, New York; Research Triangle Park, North Carolina; and Los Angeles, California. These studies included healthy elderly individuals and elderly subjects with underlying cardiovascular disease, COPD, hypertension, and a history of myocardial infarctions among others. For each study, personal exposure measurements of PM_{2.5} and/or PM₁₀ were made. Measurements were also taken at ambient, outdoor residential, and indoor residential locations. Copollutants such as CO, ozone, NO₂, SO₂, metals, and carbon were

also measured. For each participant, information on time/activity patterns and potential sources of PM exposure was collected through an OMB-approved questionnaire. Participants were monitored over time (7-28 days) to investigate both longitudinal and cross-sectional correlations between personal, indoor, outdoor, and ambient measurements. Specific human health effects information, such as heart rate variability, lung function, and blood pressure data were monitored in some instances.

**Results and
Implications**

Field data collections for the panel studies have been completed. These studies involved measurements taken with 14 discreet combinations of subpopulation/season/location. Data from over 200 participants living in eight major metropolitan areas (Boston, Los Angeles, Baltimore, Research Triangle Park, Seattle, Fresno, New York, and Atlanta) were involved during the 1998-2001 study period. More than 15,000 filter samples from personal, residential and outdoor settings were collected and analyzed for integrated (24-h) PM mass concentrations. This represents over 4,000 sampling days of individual human exposure to PM and an equivalent amount of collected time-activity pattern data. Several studies showed that, for individuals with little exposure to non-ambient sources, correlations between personal exposure and ambient PM concentration are high. Even for these studies correlations varied by individual depending upon their activities and the microenvironments they occupied. Individual personal PM exposures and the relationship to ambient concentrations may vary by season, residential and geographical setting and subject groupings. Building type and ventilation characteristics strongly influence both exposure levels and the relationship with ambient concentrations. Numerous peer-reviewed journal articles have been published based on the results from the exposure studies with additional data summaries expected during FY2002. The published journal articles provided integral information for ORD's Ambient Air Quality Criteria for Particulate Matter (2001 PM AAQCD).

**Research
Collaboration and
Publications**

The PM Longitudinal Panel Studies were designed and conducted by research teams at the US EPA's National Exposure Research Laboratory, the U.S. EPA's National Health and Environmental Effects Research Laboratory, The University of Washington, Harvard University, and New York University, and Research Triangle Institute.

Extramural federal funding for this research was administered under EPA cooperative assistance agreement CR8271177 (University of Washington), CR827159 (Harvard University), CR827164 (New York

University), CR820076 (University of North Carolina-Chapel Hill) as well as EPA contracts 68-D5-0040, 68-D-99-012 (Research Triangle Institute), 68-D2-0134 (QST Environmental), and 68-D2-0187 (SRA Technologies).

Recent publications from this effort include:

- Liao, D., Creason, J., Shy, C., Williams, R., Watts, R., and Zweidinger, R. "Daily variation of particulate air pollution and poor cardiac autonomic control in the elderly." *Environmental Health Perspectives* 107:521-525 (1999).
- Williams, R., Watts, R., Stevens, R., Stone, C., and Lewtas, J. "Evaluation of a personal air sampler for twenty-four hour collection of fine particles and semivolatile organics." *Journal of Exposure Analysis and Environmental Epidemiology* 2: 158-166 (1999).
- Evans, G., Highsmith, R., Sheldon, L., Suggs, J., Williams, R., Zweidinger, R., Creason, J., Walsh, D., Rodes, C., and Lawless, P. "The 1999 Fresno particulate matter exposure studies, comparison of community, outdoor, and residential PM mass measurements." *Journal of Air and Waste Management Association* 50: 1887-1896 (2000).
- Williams, R., Creason, J., Zweidinger, R., Watts, R., Sheldon, L., and Shy, C. "Indoor, outdoor, and personal exposure monitoring of particulate air pollution: The Baltimore elderly epidemiology-exposure pilot study." *Atmospheric Environment* 34: 4193-4204 (2000).
- Reed, C.H., Rea, A., Zufall, M., Burke, J., Williams, R., Suggs, J., Sheldon, L., Walsh, D., and Kwok, R. (in press). "Use of a continuous nephelometer to measure personal exposure to particles during the U.S. EPA Baltimore and Fresno Panel Studies." *Journal of Air and Waste Management Association* 50: 1125-1132 (2000).
- Williams, R., Suggs, J., Zweidinger, R., Evans, G., Creason, J., Kwok, R., Rodes, C., Lawless, P., and Sheldon, L. "The 1998 Baltimore particulate matter epidemiology-exposure study: part 1-Comparison of ambient, residential outdoor, indoor and apartment particulate matter monitoring." *Journal of Exposure Analysis and Environmental Epidemiology* 10:518-532 (2000).
- Williams, R., Suggs, J., Creason, J., Rodes, C., Lawless, P., Kwok, R., Zweidinger, R., and Sheldon, L. "The 1998 Baltimore particulate matter epidemiology-exposure study: Part 2- Personal Exposure Assessment associated with an elderly study population." *Journal of Exposure Analysis and Environmental Epidemiology* 10:533-543 (2000).
- Williams, R., Suggs, J., Zweidinger, R., Evans, G., Creason, J., Kwok, R., Rodes, C., Lawless, P., and Sheldon, L. "Comparison of PM_{2.5} and PM₁₀ monitors." *Journal of Exposure Analysis and Environmental Epidemiology* 10:497-505 (2000).
- Creason, J., Neas, L., Shy, C., Williams, R., Sheldon, L., Liao, D., and Walsh, D. "Effects of particulate matter on the heart rate variability of elderly residents in an east coast retirement community: the Baltimore 1998 PM study." *Journal of Exposure Analysis and Environmental Epidemiology* 11:116-123 (2001).
- Vette, A., Rea, A., Lawless, P., Rodes, C., Evans, G., Highsmith, R., and Sheldon, L. "Characterization of indoor-outdoor aerosol concentration relationships during the Fresno PM exposure studies." *Aerosol Science and*

Technology 34:118-126 (2001).

Rodes, C., Lawless, P., Evans, G., Sheldon, L., Williams, R., Vette, A., Creason, J., and Walsh, D. "The relationships between personal PM exposures for elderly populations and indoor and outdoor concentrations for three retirement center scenarios." *Journal of Exposure Analysis and Environmental Epidemiology* 11:103-116 (2001).

Conner, T., Norris, G., Landis, M., and Williams, R. "Individual particle analysis of indoor, outdoor, and personal samples from the 1998 Baltimore retirement home study." *Atmospheric Environment*, in press (2001).

Rea, A., Zufall, M., Williams, R., Reed, C., and Sheldon, L. "The influence of human activity patterns on personal PM exposure: a comparative analysis of filter-based and continuous particle measurements." *Journal of Air and Waste Management Association*, in press (2001).

Future Research

Data from the completed field studies will be validated and individual data bases developed. Statistical analysis will be conducted to

- quantify personal exposures and indoor air concentrations for PM components for potentially sensitive individuals,
- describe the relationships between personal exposure, and indoor, outdoor and ambient air concentrations for PM components for different sensitive cohorts,
- examine the inter- and intrapersonal variability in these relationships
- identify and model the factors that contribute to the inter- and intrapersonal variability in these relationships, and
- determine the contribution of ambient concentrations to indoor air/personal exposures for PM/gases.

Individual databases will be combined to examine the effects of air shed (location, season), population demographics, and residential setting (apartment versus stand-alone homes) on the relationship between personal exposure and indoor, outdoor, and ambient air concentrations for PM/gases. Results will be presented in the peer-reviewed literature. The combined database will be made publically available, thus allowing the Agency and other interested parties to access and use the data. Ultimately, these studies will provide accurate exposure data and models that will provide the sound scientific basis needed for implementing the National Ambient Air Quality Standard for PM.

**Contacts for
Additional
Information**

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